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FOREST SERVICE

FOREST PEST MANAGEMENT

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STATE & PRIVATE FORESTRY

INTERMOUNTAIN REGION

EFFECTS OF DEFOLIATION BY PINE BUTTERFLY[1] IN SOUTHWESTERN IDAHO

Plot Establishment 1983 - 1984

R. W. Thier[2]

INTRODUCTION

Beginning in 1979, flights of pine butterflies, Neophasia menapia (Felder & Felder), were noticed throughout much of the ponderosa pine type in southwestern Idaho. Ponderosa pines on 500 to 600 acres near Dry Buck Summit northwest of Banks, Idaho, were defoliated in 1981. In 1982 defoliation around Dry Buck Summit continued and new areas of defoliation were noticed north of Cascade, Idaho. Finally, in 1983 a total of approximately 16,200 acres of defoliation was recorded north of Cascade, Idaho, east of Cascade Reservoir, and in the Dry Buck Summit vicinity. The course of this infestation has been reported by Thier (1982, 1983) and Thier et al. (1984).

Even though pine butterfly feeding may cause severe defoliation of infested trees, effects of this insect's feeding on tree growth and development have not been well documented. Evenden (1940) reported that 26% of his study trees died following defoliation by pine butterfly in 1922. Pine butterfly defoliation alone was responsible for killing 12% of these trees and subsequent bark beetle attack killed the other 14%. Following a 1952-1954 outbreak Cole (1966) reported less than 2% mortality of his sample trees. Both authors reported an approximate 39% reduction of expected normal radial growth increment among those trees that recovered following defoliation.

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[1] Neophasia menapia (Felder & Felder) (Lepidoptera: Pieridae)

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To better elucidate pine butterfly feeding effects on ponderosa pine in southwestern Idaho, data were collected from 4 pine butterfly-infested ponderosa pine stands in 1983 and 1984. This report documents plot establishment and baseline tree information.

METHODS

The survey design was similar to that presented by Bousfield (1980).

Stand Selection

Pine butterfly infested stands identified during the 1982 aerial detection survey were outlined on aerial photographs and topographic maps. Criteria for selecting sample stands included: good access, composition of at least 50% host type, size of approximately 20-100 acres, and homogeneous as to species composition and density. Four stands were sampled and given identification numbers 303 to 306. Stand locations are recorded in Figures 1 and 2.

Data Acquisition

Sample points were spaced at approximately 5-chain intervals along lines with 6 to 16 points established in each stand. Lines were predetermined to traverse the stand establishing sample points throughout. Point locations are referenced in permanent files in the Boise Field Office of Forest Pest Management. At each point two data collection plots were established: a variable plot with a basal area factor of 40 from which data from trees 5 inches or larger in diameter at breast height (DBH) were collected, and a 1/300-acre fixed plot from which data on trees less than 5 inches DBH were gathered. Each sample tree was permanently marked with green paint and plot center was marked with a painted stake. Species, DBH, crown ratio, crown class, and presence of insect or disease were recorded for each sample tree. The severity of defoliation by pine butterfly was subjectively estimated on a percent scale to the nearest 5%. Defoliation was also classified as light (<10%), moderate (10-60%), or heavy (>60%). Length of top-kill, if present, was measured for each host tree on the sample point.

Additionally, at each variable plot tree height was determined for the first 4 live trees encountered around plot center in a clockwise direction starting at the cruise line. If a tree had a broken or forked top the next tree encountered in the clockwise rotation was measured for height. Increment cores were extracted at DBH from these same trees to obtain radial growth data. Age was determined from the increment core for the first tree. Increment cores were measured for annual radial growth for both the 2-year defoliation period and the 2-year period preceeding the onset of defoliation. Some increment cores were sent to the Intermountain Forest and Range Experiment Station at Moscow, Idaho, for radial growth ring measurements. Others were returned to the laboratory where radial growth ring measurements were made with the aid of a dissecting microscope fitted with an ocular micrometer.

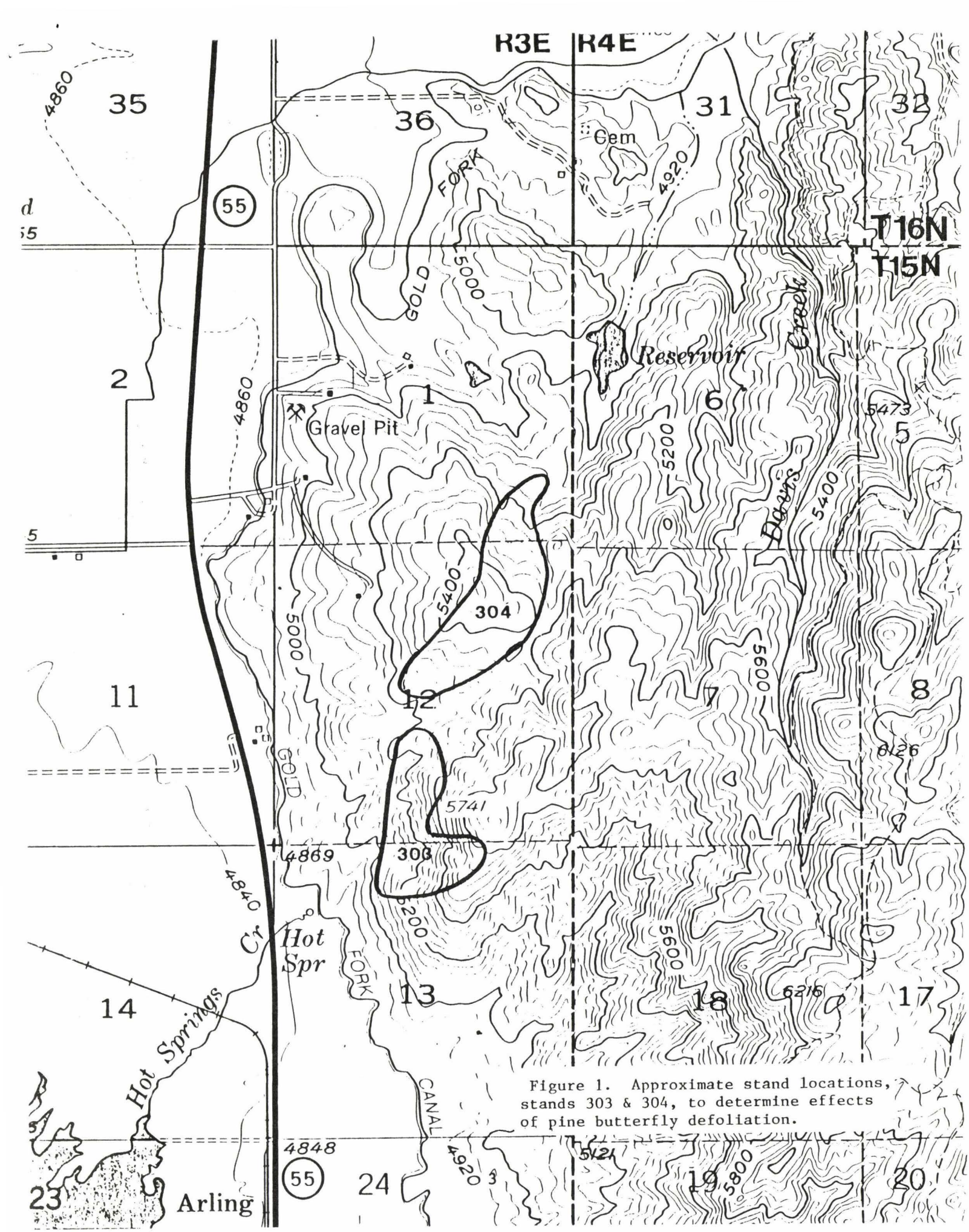

Figure 1. Approximate stand locations, stands 303 & 304, to determine effects of pine butterfly defoliation.

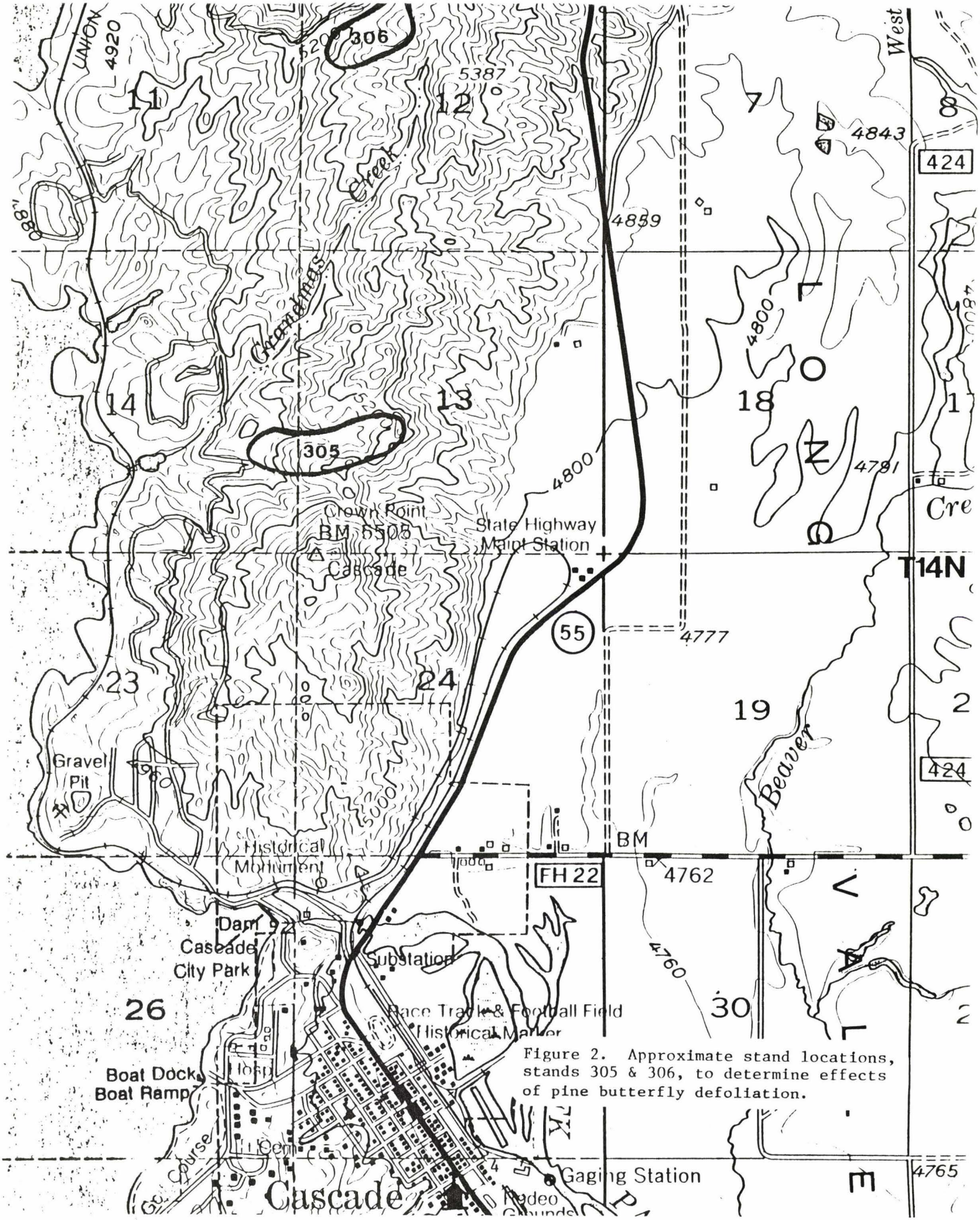

Figure 2. Approximate stand locations, stands 305 & 306, to determine effects of pine butterfly defoliation.

General site information such as habitat type, percent slope, and aspect was recorded for each stand. Blank sample data collection forms are included in the appendix.

Data Analysis

All data were edited, placed on file at the Fort Collins Computer Center, and analyzed using the INDIDS computer program (Bousfield 1980). INDIDS summarized the sample tree data yielding a series of tables which depict current stand conditions.

SUMMARY OF CONDITIONS

Basic stand information is contained in Tables 1 and 2. Average stand ages ranged from 53 to 68 years. Stand densities ranged from 77 to 115 square feet of basal area with stocking from 128 to 196 trees per acre. Individual tree information is found in the appendix.

Specific ponderosa pine conditions for each stand are discussed below:

Arling Hot Spring #1 (303) - Table 3 summarizes the ponderosa pine conditions at Arling Hot Spring #1 in 1983. Defoliation was observed in all diameter classes. Percent defoliation was determined from a total of 42 trees and averaged 39.88% (S.E.=3.34). There was no pine butterfly-caused top-kill or mortality. Other damage was caused by animals. Many survey trees were lost in late 1983 when the stand was logged; therefore, a subsequent 1984 survey was not conducted.

Arling Hot Spring #2 (304) - Table 4 summarizes the ponderosa pine conditions at Arling Hot Spring #2 in 1983. Defoliation was observed in the 5 to 8.9" and 12+" DBH diameter class trees. Percent defoliation was determined from a total of 23 trees and averaged 8.04% (S.E.=3.28). There was no pine butterfly-caused top-kill or mortality. Other damage was caused by needle disease, shoot insects, bark beetles, decay, and unidentified agents. Mortality in the 5 to 8.9" DBH diameter class trees was attributed to bark beetles.

Table 5 summarizes the ponderosa pine conditions in 1984. Defoliation was observed in the 0 to 8.9" and 12+" DBH diameter class trees. Percent defoliation was determined from a total of 21 trees and averaged 25.48% (S.E.=5.51). Defoliation in 1984 was both more extensive and intensive than in 1983. There was no pine butterfly-caused top-kill nor mortality. Other damage was caused by bark beetles.

Crown Point (305) - Table 6 summarizes the ponderosa pine conditions at Crown Point in 1983. Defoliation was observed in the 5 to 8.9" and 12+" DBH diameter class trees. Percent defoliation was determined from a total of 12 trees and averaged 39.58% (S.E.=2.08). There was no pine butterfly-caused top-kill nor mortality. Other damage was caused by bark beetles.

Table 1. Pine butterfly impact - Sample stand location and evaluation data - 1983

Stand Identification Number	Location	Legal Description	Number of Sample Points	Approximate Size (acres)
303	Arling Hot Spring #1	T15N R3E sec 12,13	16	57
304	Arling Hot Spring #2	T15N R3E sec 12	16	93
305	Crown Point	T14N R3E sec 13,14	8	43
306	Little Donner	T14N R3E sec 12	6	31

Table 2. Pine butterfly impact - Sample stand composition - 1983

Location	Stand Age (yrs) mean ± S.E. (n)	Habitat Type[1]	Basal Area (ft^2)				Number of Trees per Acre			
			Grand Fir	Douglas-fir	Ponderosa pine	Total	Grand Fir	Douglas-fir	Ponderosa pine	Total
Arling Hot Spring #1	68.45 ± 3.44 (11)	Psme/Spbe	-0-	-0-	104.5	104.5	-0-	-0-	140.4	140.4
Arling Hot Spring #2	64.5 ± 6.89 (22)	Psme/Spbe	2.5	7.5	67.0	77.0	3.7	7.8	184.3	195.7
Crown Point	54.13 ± 1.49 (8)	Psme/Caru	-0-	20.0	65.0	85.0	-0-	39.7	89.1	128.8
Little Donner	53.4 ± 4.03 (5)	Psme/Caru	-0-	35.5	80.0	115.5	-0-	99.3	74.8	174.0

[1] habitat types according to Steele et al. (1981)

Table 3. Pine butterfly impact - Ponderosa pine conditions Arling Hot Spring #1 [303] - 1983

	Diameter Class [inches DBH]	Unaffected	Defoliation			Other Damage	Other Mortality	Total Stand
			Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	37.5	-0-	-0-	37.5
basal area[1]					4.5			4.5
	5 - 8.9							
trees/acre		-0-	7.2	5.8	7.0	-0-	-0-	20.1
basal area			2.5	2.5	2.5			7.5
	9 - 11.9							
trees/acre		-0-	10.1	16.3	11.2	-0-	-0-	37.5
basal area			5.0	10.0	7.5			22.5
	12+							
trees/acre		-0-	7.5	37.8	-0-	2.5[2]	-0-	45.2
basal area			10.0	60.0		2.5		70.0
	Total							
trees/acre		-0-	24.7	60.0	55.7	2.5	-0-	140.4
basal area			17.5	72.5	14.5	2.5		104.5

[1] square feet
[2] animal damage

Table 4. Pine butterfly impact - Ponderosa pine conditions Arling Hot Spring #2 (304) - 1983

	Diameter Class (inches DBH)	Defoliation				Other Damage	Other Mortality	Total Stand
		Unaffected	Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	-0-	37.5[2]	-0-	37.5
basal area[1]						2.0		2.0
	5 - 8.9							
trees/acre		23.1	17.5	34.0	-0-	84.2[3]	15.2[4]	112.3
basal area		7.5	5.0	7.5		17.5	2.5	30.0
	9 - 11.9							
trees/acre		-0-	-0-	-0-	-0-	13.8[4]	-0-	13.8
basal area						7.5		7.5
	12+							
trees/acre		8.7	4.3	4.4	-0-	4.2[5]	-0-	20.7
basal area		10.0	5.0	7.5		7.5		27.5
	Total							
trees/acre		31.8	21.8	38.4	-0-	119.7	15.2	184.3
basal area		17.5	10.0	15.0		34.5	2.5	87.0

[1] square feet
[2] needle disease
[3] shoot insect, winter damage, needle disease, unknown agent
[4] bark beetles
[5] needle disease, decay

Table 5. Pine butterfly impact - Ponderosa pine conditions Arling Hot Spring #2 (304) - 1984

	Diameter Class (inches DBH)	Defoliation				Other Damage	Other Mortality	Total Stand
		Unaffected	Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	37.5	-0-	-0-	37.5
basal area[1]					2.0			2.0
	5 - 8.9							
trees/acre		-0-	-0-	65.1	-0-	54.7[2]	-0-	112.3
basal area				17.5		15.0		30.0
	9 - 11.9							
trees/acre		-0-	-0-	-0-	-0-	13.8[2]	-0-	13.8
basal area						7.5		7.5
	12+							
trees/acre		1.7	10.6	8.4	-0-	-0-	-0-	20.7
basal area		2.5	15.0	10.0				27.5
	Total							
trees/acre		1.7	10.6	73.5	37.5	68.5	-0-	184.3
basal area		2.5	15.0	27.5	2.0	22.5		67.0

[1] square feet
[2] bark beetles

Table 6. Pine butterfly impact - Ponderosa pine conditions Crown Point (305) - 1983

	Diameter Class (inches DBH)	Unaffected	Defoliation			Other Damage	Other Mortality	Total Stand
			Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	-0-	-0-	-0-	-0-
basal area[1]								
	5 - 8.9							
trees/acre		-0-	-0-	36.4	-0-	14.7[2]	-0-	51.1
basal area				10.0		5.0		15.0
	9 - 11.9							
trees/acre		-0-	-0-	-0-	-0-	-0-	-0-	-0-
basal area								
	12+							
trees/acre		-0-	-0-	38.0	-0-	-0-	-0-	38.0
basal area				50.0				50.0
	Total							
trees/acre		-0-	-0-	74.4	-0-	14.7	-0-	89.1
basal area				60.0		5.0		65.0

[1] square feet
[2] bark beetles

Table 7. Pine butterfly impact - Ponderosa pine conditions Crown Point (305) - 1984

	Diameter Class (inches DBH)	Defoliation				Other Damage	Other Mortality	Total Stand
		Unaffected	Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	-0-	-0-	-0-	-0-
basal area[1]								
	5 - 8.9							
trees/acre		-0-	-0-	36.4	-0-	14.7[2]	-0-	51.1
basal area				10.0		5.0		15.0
	9 - 11.9							
trees/acre		-0-	-0-	-0-	-0-	-0-	-0-	-0-
basal area								
	12+							
trees/acre		-0-	-0-	38.0	-0-	-0-	-0-	38.0
basal area				50.0				50.0
	Total							
trees/acre		-0-	-0-	74.4	-0-	14.7	-0-	89.1
basal area				60.0		5.0		65.0

[1] square feet
[2] bark beetles

Table 8. Pine butterfly impact - Ponderosa pine conditions Little Donner [306] - 1983

	Diameter Class (inches DBH)	Unaffected	Defoliation			Other Damage	Other Mortality	Total Stand
			Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	-0-	-0-	-0-	-0-
basal area[1]								
	5 - 8.9							
trees/acre		-0-	-0-	-0-	-0-	16.5[2]	-0-	16.5
basal area						6.7		6.7
	9 - 11.9							
trees/acre		-0-	-0-	13.8	-0-	-0-	-0-	13.8
basal area				6.7				6.7
	12+							
trees/acre		-0-	1.8	42.6	-0-	-0-	-0-	44.4
basal area			6.7	60.0				66.7
	Total							
trees/acre		-0-	1.8	56.5	-0-	16.5	-0-	74.8
basal area			6.7	66.7		6.7		80.0

[1] square feet
[2] bark beetles

Table 9. Pine butterfly impact - Ponderosa pine conditions Little Donner (306) - 1984

	Diameter Class (inches DBH)	Unaffected	Defoliation			Other Damage	Other Mortality	Total Stand
			Light	Moderate	Heavy			
	0 - 4.9							
trees/acre		-0-	-0-	-0-	-0-	-0-	-0-	-0-
basal area[1]								
	5 - 8.9							
trees/acre		-0-	-0-	-0-	-0-	16.5[2]	-0-	16.5
basal area						6.7		6.7
	9 - 11.9							
trees/acre		-0-	-0-	13.8	-0-	-0-	-0-	13.8
basal area				6.7				6.7
	12+							
trees/acre		-0-	-0-	38.1	6.3	-0-	-0-	44.4
basal area				60.0	6.7			66.7
	Total							
trees/acre		-0-	-0-	51.9	6.3	16.5	-0-	74.8
basal area				66.7	6.7	6.7		80.0

[1] square feet
[2] bark beetles

Table 7 summarizes the ponderosa pine conditions in 1984. Defoliation was observed in the 5 to 8.9" and 12+" DBH diameter class trees. Percent defoliation was determined from a total of 12 trees and averaged 37.08% (S.E.=3.51). Conditions had not changed between 1983 and 1984.

Little Donner (306) - Table 8 summarizes the ponderosa pine conditions at Little Donner in 1983. Defoliation was observed in the 9 to 12+" DBH diameter class trees. Percent defoliation was determined from a total of 11 trees and averaged 43.64% (S.E.=4.63). There was no pine butterfly-caused top-kill or mortality. Other damage was caused by bark beetles.

Table 9 summarizes the ponderosa pine conditions in 1984. Defoliation was observed in the 9 to 12+" DBH diameter class trees. Percent defoliation was determined from a total of 11 trees and averaged 40.0% (S.E.=4.52). Defoliation became more intensive in the 12+" DBH diameter class trees from 1983 to 1984. Overall, defoliation became less intensive declining from 43.64% in 1983 to 40.0% in 1984. There was no pine butterfly-caused top-kill nor mortality. Other damage was caused by bark beetles.

FUTURE ASSESSMENTS

Presently, pine butterfly has caused no mortality or top-kill and the analysis of the effect of defoliation on radial growth will be determined following future assessments. Results of this survey will help land managers understand the effects of pine butterfly defoliation in southern Idaho and provide data for future management decisions.

Assessment of the effects of forest defoliators is a long term undertaking. The often cited impacts of mortality, top-kill, and reduced radial growth may be offset in the long term due to increased rates of nutrient cycling and reduced stand density resulting in improved tree growth and vigor.

I recommend that the percent defoliation be assessed in these stands annually as long as the pine butterfly outbreak lasts and that tree measurements, similar to those obtained in 1983 and 1984, be taken 3 to 5 years following termination of the infestation. Data will be summarized, analyzed with regard to significance of defoliation on tree mortality, height growth, and radial growth, and reported in a regional report.

ACKNOWLEDGEMENTS

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R-4 FPM IMPACT SURVEY
HEADER SHEET

ID Code _ _ _ (1-3)

Forest _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ (4-19)

Stand or Area _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ (20-35)

Survey Code _ _ (36-37) Type _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ (38-51)

Observers _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ (52-66)

Green Tree Plots _ _ (67-68) Type Plot _ (69) Size Plot _ _ (70-71)

Total Plots _ _ _ (72-74) Date _ _ (75-76) _ _ (77-78) _ _ (79-80)

Slope _____

Aspect _____

Elevation _____

Physo Site _____

Habitat _____

Soil _____

BAF _____

Fixed _____

Year Defoliation Detected _____

Total Years Defoliated _____

REMARKS & DIRECTIONS

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R-4 FPM IMPACT SURVEY
TREE DATA FORM

CREW _____
DATE _____
PAGE _____ OF _____

PLOT DATA			TREE DATA			GROWTH DATA				"INDIDS" DAM CODES			GENERAL			CROWN		PROGNOSIS DAMAGE DATA			EXTRA GROW DATA	
ID CODE	PLOT #	HAB TYPE	SPECIE	DBH	HEIGHT	AGE	10 YR INCR LAST	10 YR INCR PREV	5 YR GROWTH HEIGHT	#1	#2	#3	HISTORY	TVC	IPRSC	RATIO	CLASS	DAM CODE	% DEF	HEIGHT TO TP KL	LAST YEAR	DPTH OF SAPW
1-3	5-6	8-10	12-14	16-18	20-22	24-26	28-30	32-34	36-38	40 41	43 44	46 47	49	50	51	54	55	58 59	61 62	64-66	68 69	71-7

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Table 1a. Pine butterfly impact - Individual tree data Arling Hot Spring #1 (303) - 1983

Plot#	Tree#	Species[1]	DBH(in) 1983	Height(ft) 1983	Age(yr) 1983	Percent Defoliation 1983	Annual Radial Increment (0.1mm) 1984	1979	1980	1981	1982	Remarks
1	1	PP	18.0	88	65	50						forked top
1	2	PP	13.8	70		60	Increment Cores Missing					
2	1	PP	28.8	122		45	for Entire Stand					
2	2	PP	10.2	54	55	55						
2	3	PP	8.8	50		45						
3	1	PP	9.5	43	77	35						forked top
3	2	PP	11.3	64		45						
3	3	PP	15.3	78		55						
3	4	PP	8.1	33		80						broken top
3	5	PP	4.5			70						
3	6	PP	11.7			65						
3	7	PP	4.9			65						
4	1	PP	22.1	77	85	40						
5	1	PP	15.3	77	80	45						
5	2	PP	14.1	72		50						
6	1	PP	11.9	87	70	75						
6	2	PP	10.0	71		70						
6	3	PP	13.6	85		45						
6	4	PP	11.9	73		80						
6	5	PP	15.7			40						
7	1	PP	25.5	92		50						
7	2	PP	27.1	91		35						
8	1	PP	21.5	87	80	30						
9	1	PP	20.2	72	75	45						
9	2	PP	19.5	80		25						
10	1	PP	15.2	70	70	40						
10	2	PP	14.1	69		40						
10	3	PP	20.3	84		60						
11	1	PP	19.1	82	70	40						
11	2	PP	25.9	80		55						
12	1	PP	13.5	51	46	20						
12	2	PP	13.9	54		15						
12	3	PP	9.0	52		10						

[1] PP - ponderosa pine, DF - Douglas-fir, GF - grand fir

Table 1a. Pine butterfly impact - Individual tree data Arling Hot Spring #1 (303) - 1983 continued

Plot#	Tree#	Species[1]	DBH(in) 1983	Height(ft) 1983	Age(yr) 1983	Percent Defoliation 1983	Annual Radial Increment (0.1mm) 1984	1979	1980	1981	1982	Remarks
12	4	PP	8.0	53		5						dead top at 26 feet
12	5	PP	10.2			10	Increment Cores Missing					
12	6	PP	13.1			5	for Entire Stand					
13	1	PP	21.3	71	81	15						
15	1	PP	16.5	64	75	5						
15	2	PP	13.8	63		15						
16	1	PP	16.9	73	48	20						
16	2	PP	16.4	71		10						
16	3	PP	18.1	70		5						

[1] PP - ponderosa pine, DF - Douglas-fir, GF - grand fir

Table 2a. Pine butterfly impact - Individual tree data Arling Hot Spring #2 (304) - 1983-1984

Plot#	Tree#	Species[1]	DBH(in) 1983	Height(ft) 1983	Age(yr) 1983	Percent Defoliation 1983	Percent Defoliation 1984	Annual Radial Increment (0.1mm) 1979	1980	1981	1982	Remarks
1	1	PP	7.5	45	55	0	20	0.9	1.1	1.3	1.1	shoot insects
1	2	DF	12.9	82	50	0	0	1.4	1.8	1.9	2.1	
2	1	PP	13.0	84	70	0	10	1.4	1.3	1.8	1.2	
2	2	PP	6.4	52	63	5	20	0.3	0.3	0.4	0.5	light needle disease
3	1	PP	9.0									older bark beetle attack
3	2	PP	4.0	28		0	90					light needle disease
3	3	PP	2.0	19		0	95					light needle disease
4	1	PP	16.2	71	55	0	10	1.6	2.7	2.8	2.9	logging damage
5	1	PP	16.2	83	47	0	0	1.0	1.3	1.8	1.4	
5	2	PP	8.4	65	52	0	15	0.9	1.2	1.4	0.5	logging damage
5	3	PP	13.3	70	50	0	5	0.7	0.8	1.4	1.2	
5	4	PP	5.5	52	38	0		0.8	0.4	0.5	0.5	1984 bark beetle attack
5	5	PP	7.8			0	15					
5	6	PP	7.1			0	30					
5	7	PP	13.3			0	20					
6	1	PP	11.8	66	50			0.5	0.5	0.8	0.2	1982 bark beetle attack
7	1	DF	18.0	73	65	0	0	1.4	2.5	3.0	3.1	
8	1	DF	11.5	75	101	5	0	1.0	0.8	1.0	0.4	light mistletoe infection
8	2	GF	11.1	67	60	10	15	0.8	0.4	0.8	1.2	
9	1	PP	27.6	95	171	0	5	2.8	2.1	1.7	1.7	
10	1	PP	7.1	31	103	0	20	0.1	0.1	0.1	0.2	dead top at 30 feet
10	2	PP	17.7	84	120	15	15	0.6	0.8	1.0	0.7	
11	1	PP	23.0	91		15	10	0.8	1.7	2.2	1.8	stem decay
12	1	PP	7.3	25	41	60		0.3	0.3	0.3	0.3	1984 bark beetle attack
12	2	PP	14.8	75	51	15	10	1.8	2.5	3.7	2.9	
13	1	PP	8.8									older bark beetle attack
13	2	PP	9.7									older bark beetle attack
14	1	PP	16.1	82	50	5	40	0.9	1.4	1.0	1.2	
14	2	PP	13.4	64	55	45	20	9.4	1.1	1.3	2.7	
15	1	PP	7.4									1982 bark beetle attack
15	2	PP	5.3	30	36	15	40	0.6	0.7	0.8	0.8	
16	1	PP	8.5	37	35	10	45	0.5	0.6	0.5	0.2	heavy needle disease

[1] PP - ponderosa pine, DF - Douglas-fir, GF - grand fir

Table 3a. Pine butterfly impact - Individual tree data Crown Point (305) - 1983 - 1984

Plot#	Tree#	Species[1]	DBH(in) 1983	Height(ft) 1983	Age(yr) 1983	Percent Defoliation 1983	Percent Defoliation 1984	Annual Radial Increment (0.1mm) 1979	1980	1981	1982	Remarks
1	1	DF	13.2	67	60	0	15	3.2	3.6	2.8	2.9	
2	1	PP	12.6	56	50	30	25	2.1	0.8	1.4	1.6	
3	1	DF	12.3	64	57	0	0	2.0	3.5	2.8	2.5	
3	2	DF	7.5	53		0	0	0.6	0.5	0.8	0.8	
3	3	PP	12.4	64		45	30	1.5	1.5	1.6	1.0	
3	4	PP	7.9									older bark beetle attack
4	1	PP	17.6	75	56	40	15	2.1	1.7	2.6	2.4	
5	1	PP	16.6	68	53	35	35	2.5	2.5	3.5	2.4	forked top
6	1	PP	19.5	64	53	45	45	1.0	1.4	1.7	1.6	
6	2	PP	15.5	57		50	50	1.1	1.3	2.2	1.7	
6	3	PP	17.3	59		45	45	0.5	1.0	1.4	1.1	
7	1	PP	19.0	59	57	50	35	1.9	2.4	2.5	2.0	
7	2	PP	7.0	32		35	50	0.3	0.4	0.6	0.3	
7	3	PP	14.8	49		35	35	2.5	3.0	3.7	2.0	
8	1	PP	15.2	51	47	30	25	0.9	1.5	1.4	1.1	
8	2	PP	7.2	34		35	55	0.4	0.4	0.4	0.4	
8	3	DF	8.7	59		0	0	1.7	2.0	2.5	2.3	

[1] PP - ponderosa pine, DF - Douglas-fir, GF - grand fir

Table 4a. Pine butterfly impact - Individual tree data Little Donner (306) - 1983 - 1984

Plot#	Tree#	Species[1]	DBH(in) 1983	Height(ft) 1983	Age(yr) 1983	Percent Defoliation 1983	Percent Defoliation 1984	Annual Radial Increment (0.1mm) 1979	1980	1981	1982	Remarks
1	1	PP	19.2	57	53	50	30	2.2	1.5	1.1	1.5	
1	2	PP	18.2	56		40	25	1.5	1.5	1.4	1.0	
1	3	PP	17.4	55		35	20	1.3	2.2	2.5	1.5	
1	4	PP	15.1	55		50	40	1.1	1.4	1.8	1.6	
2	1	PP	26.3	65	57	10	40	3.3	3.6	4.6	3.0	
2	2	PP	12.3	54		35	35	1.0	0.8	1.3	1.2	
2	3	PP	13.1	54		45	40	2.9	2.5	2.2	1.5	
3	1	PP	9.4	48	38	60	60	0.7	0.7	0.4	0.3	
3	2	DF	2.8	16								logging damage
4	1	DF	13.0									mistletoe mortality
4	2	PP	8.8									older bark beetle attack
5	1	PP	23.8	86	59	45	50	2.3	1.4	1.5	1.4	
5	2	DF	9.3	56		40	45	0.7	0.6	0.8	0.6	
5	3	DF	13.7	67		25	20	1.4	1.8	2.1	1.0	
5	4	PP	20.5	76		40	30	1.4	1.7	1.8	1.4	
6	1	DF	13.8	73	60	30	0	3.0	2.7	3.0	3.3	
6	2	PP	13.9	78		70	70	0.8	0.7	0.8	0.4	
6	3	DF	9.0	58		20	20	0.9	0.9	1.5	1.5	stem decay

[1] PP - ponderosa pine, DF - Douglas-fir, GF - grand fir